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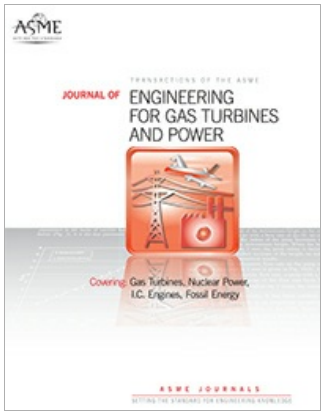

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RESEARCH-ARTICLE

Numerical Study of Cage Dynamics Focused on Hydrodynamic Effects of Guidance Land Clearances for Different Ball-Pocket Clearances in Cryogenic Environments

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This study presents the dynamic motion of a ball bearing cage submerged in a cryogenic fluid under high-speed conditions. The dynamic motion of the cage has been studied as a function of the race land-cage and ball-cage pocket clearances for different inner race rotation speeds under light load conditions. In addition, this study conducted computational fluid dynamics (CFD) analysis using commercial software to analyze the fluid dynamic forces on the cage. The hydraulic force obtained from the CFD analysis was coded in commercial ball bearing analysis software as a function of the eccentricity ratio and rotation speed of the cage. Finally, the dynamic motion of the ball bearing cage considering the effects of fluid dynamic forces has been studied. The results include the cage whirling amplitude, fluctuation of cage whirling speed, and cage wear for various cage clearances and rotation speeds. The cage whirling amplitude decreases as the outer guidance clearance decreases, and it decreases as the rotation speed increases up to 11,000 rpm because of the increasing hydrodynamic force of the liquid nitrogen (LN_2). However, the probability density function curves indicate that an increase in the rotor speed increases the standard deviation in the cage whirling frequency. The wear loss of the cage was greatest for the largest race land-cage and the smallest ball-cage pocket clearances. Consequently, the analysis results for various operating conditions (inner race rotation speeds, cage clearances, traction coefficients, etc.) are in good agreement with the reference results.

Issue Section: Gas Turbines: Structures and Dynamics
Keywords: Computational fluid dynamics, Design optimization, Environmental, Vibration
Topics: Ball bearings, Clearances (Engineering), Computational fluid dynamics, Dynamics (Mechanics), Fluids, Rotation, Traction, Wear, Whirls, Boundary-value problems, Design, Stress

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